

ORIGINAL RESEARCH

Effect of Waterlase laser retrograde root-end cavity preparation on the integrity of root apices of extracted teeth as demonstrated by light microscopy

James A. Wallace, DDS, MDS, MSD, MS

School of Dental Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA

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Correspondence

Dr James A. Wallace, School of Dental Medicine, University of Pittsburgh, 3501 Terrace Street, 3064 Salk Annex, Pittsburgh, PA 15261, USA.
Email: jawsdds@aol.com

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Abstract

Most endodontists use ultrasonic instruments for retrograde root-end cavity preparations even though they have been found to produce cracks. In this laboratory study, thirty-six randomly chosen roots had root-end cavity preparations made with the Waterlase laser and only one questionable intra-canal crack was found. It was concluded that the Waterlase laser when used to make endodontic root-end cavity preparations produces either no cracks, or a very low percentage (2.8%) of cracks.

Introduction

Most endodontists consider ultrasonics as the method of choice for retrograde root-end cavity preparation. Several authors have found ultrasonic root-end cavity preparation produces cracks and/or chipping. (Table 1).

The Biolase Waterlase (Biolase © Technology, Inc. San Clemente, CA, USA) Er-Cr:YSGG (Erbium, Chromium: Yttrium, Scandium, Gallium and Garnet) pulsed laser has been found to be useful in endodontic surgery for root-end resection, root-end cavity preparation, haemostasis, and sterilization of the root apex and surrounding tissue. For restorative procedures, laser use has increased patient acceptance related to pain, vibrations, whine of the drill, micro-fractures and heat production (15). This laser cuts hard tissue with highly energised water particles and soft tissue directly with laser energy. (15) Preliminary studies looking at the safety and efficacy of using the ErCr:YSGG laser found it to be a proficient instrument in cutting bone. (16) FDA approval for apicoectomy surgery was granted on 12 February 2002 and flap surgery on 3 February 2003. Gouw-Soares (17) demonstrated the Er:YAG (Erbium:Yttrium-Aluminium Garnet), Ga-Al-As (Gallium Aluminium Arsenide) and Nd:YAG (Neodymium: Yttrium-Aluminium Garnet) lasers, when used in combination for performing an apicoectomy, produced heat

which may lead to cracking. Root-end cavity preparation should be three millimetres in depth and the resection angle should be zero (18,19).

The purpose of this study was to determine if root-end preparations at a depth of three millimetres in resected roots at a zero angle performed by the Waterlase laser produce cracks and/or chipping. To the author's knowledge there is no published data on the use of the Waterlase laser for this purpose.

Materials and methods

Seventeen extracted teeth, comprising eight mandibular molars, five maxillary molars, three bicuspid and one central incisor were chosen at random for a total of thirty-six root apices.

The teeth were stored in 0.9% sodium chloride and 1% sodium hypochlorite solution to preserve and inhibit microbial growth. All the teeth apices were preoperatively evaluated by two independent investigators with a fibre-optic translucent light source for a time period not exceeding 2 min using a Fisher stereomicroscope (FSM) at ×40 magnification and a Global Surgical Microscope (GSM) at ×12 magnification with digital photographs being taken at this time (20).

Table 1 Ultrasonic and bur root-end preparation *in vitro*

Paper	Type of instrument	Frequency of cracks	Assessment
Abedi <i>et al.</i> (1)	Fissure bur and ultrasonic	Significantly more cracks with ultrasonic versus bur	SEM
Layton <i>et al.</i> (2)	Ultrasonic low and high	More than 40% demonstrated cracks	Dye and microscope
Frank <i>et al.</i> (3)	Bur slow and high speed, sonic ultrasonic medium and high	10–50% of teeth	Dye and microscope
Lloyd <i>et al.</i> (4)	Sonic and bur	Sonic 10–15% Bur 0–5%	SEM
Beling <i>et al.</i> (5)	Ultrasonic	5–10%	SEM
Min <i>et al.</i> (6)	Bur, ultrasonic Low and high	Bur 10%, ultrasonic 100%	Confocal microscopy
Brent <i>et al.</i> (7)	Ultrasonic	20–25%	SEM
Morgan and Marshall (8)	Ultrasonic	5%	SEM
Gray <i>et al.</i> (9)	Bur and ultrasonic	Bur 0% Ultrasonic 7%	SEM
Rainwater <i>et al.</i> (10)	Bur and ultrasonic	60–80% ultrasonic 10% bur	Microscope
Peters <i>et al.</i> (11)	Ultrasonic	1%	SEM
Gondim <i>et al.</i> (12)	Sonic, ultrasonic	18–80%	SEM
Ishikawa <i>et al.</i> (13)	Ultrasonic	10–20%	SEM
Khabbaz <i>et al.</i> (14)	Bur, sonic, ultrasonic	7–20%	Video microscope

SEM, standard error of the mean.

A three millimetre root-end resection was made on each root apex perpendicular to the long axis using a carbide bur in a high speed hand piece with water using GSM at $\times 12$ magnification (21). The resected root apex was again examined for cracks and photographed as above. Following root resection, the teeth were immediately placed in a solution of 0.004% aqueous methylene blue dye in distilled water (2). Forty-eight hours following immersion, two investigators independently examined the specimens using the FSM $\times 40$ magnification and photographed them with the GSM at $\times 12$ magnification (2).

The root canals of the teeth used in the study were uninstrumented and unobturated. The root-end preparations were made using the Waterlase laser with a 600 μm laser tip and a setting of four watts, 55% water and 65% air as suggested by the manufacturer. The tip was used 1–2 mm from the surface using the GSM at $\times 12$ magnification. A Class I root-end preparation was made in the 36 resected root-ends to a depth of 3 mm and approximately 1 mm in diameter confirmed with a periodontal probe. The root-end preparation was done by holding the teeth in the operator's gloved hand with the tooth surrounded by saline-soaked gauze. The root was kept moist during preparation as energised water molecules did the cutting. Following apical preparation the specimens were examined and photographed with the GSM $\times 12$ magnification (Fig. 1).

The teeth were immediately returned to the storage unit and immersed in 0.004% methylene blue solution. The total preparation time for each root was less than 2 min.

The teeth were then re-examined under the FSM at $\times 40$ magnification with transillumination by two independent investigators.

Results

The 36 roots were evaluated before resection with the GSM $\times 12$ magnification and the FSM at $\times 40$ magnification by two independent investigators using transillumination for under 2 min and no cracks were identified. Digital photographs with GSM at $\times 12$ magnification illustrated no cracks.

The root-ends were evaluated after resection as would be done in a clinical surgical situation, and no cracks were evident using the GSM at $\times 12$ magnification. Forty-eight hours following immersion in 0.004% methylene blue dye, two investigators independently examined the resected root ends with the GSM $\times 12$ magnification and the FSM at $\times 40$ magnifications with transillumination, and once again no cracks were found.

During the root-end preparation in handling the specimens with gloved hands no detectable heat was produced in the specimens, thus enhancing chances for no cracks being produced. Sample specimens before and after root-end preparation are shown in Figures 1–3.

The teeth were re-examined under the FSM at $\times 40$ magnification using transillumination by two independent investigators. One questionable intracanal crack was observed in one root-end preparation (that is, in 2.8% of specimens).

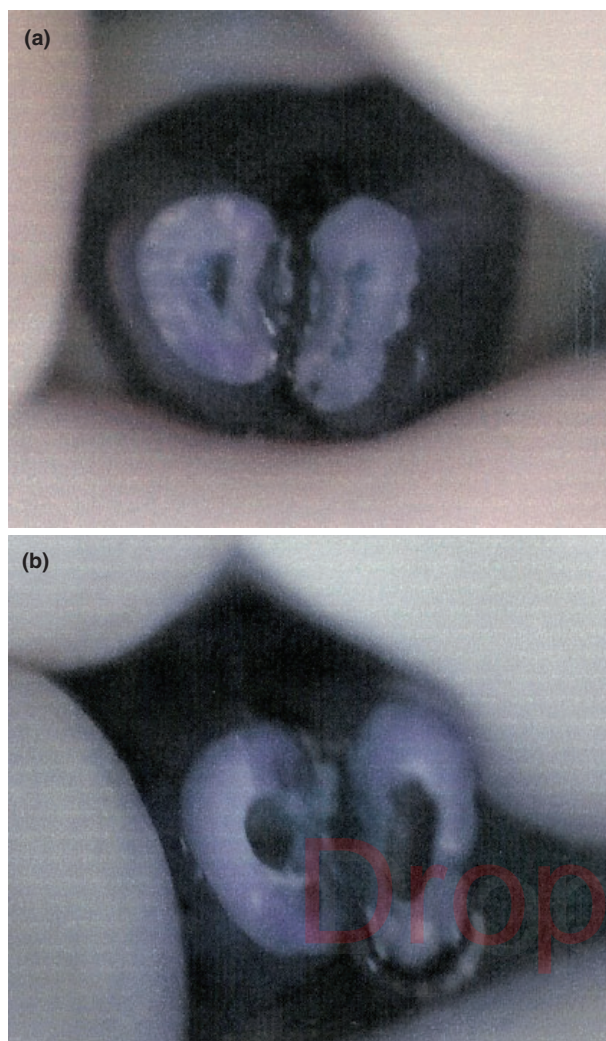


Figure 1 Pre- and post-preparation specimens.

Discussion and conclusion

Pulsed ErCr: YSGG laser energy can be used to prepare root-ends for an apical seal. It is the energised water molecules that do most of the cutting and thus it was found that the roots remained very cool to the touch during preparation, as has been noted for osseous tissue (22). No cracks were noted pre-treatment. The digital photographs with the GSM at $\times 12$ magnification were studied and no cracks were observed. It is important to note that this is the magnification typically used during clinical surgical procedures. Scanning electron microscopy examination would have been useful for closer inspection of the samples. The canals were left un-instrumented as there was no significant difference in the incidence of root cracks when canals were obturated or unobturated (6). Three millimetres of the root apices were removed with a high-speed fissure

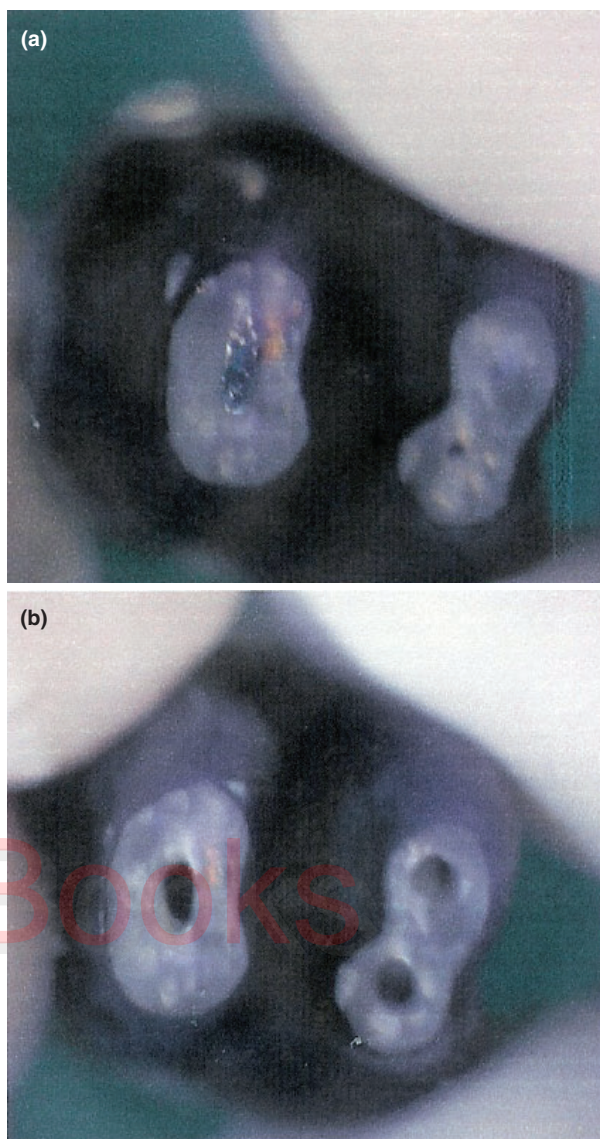


Figure 2 Pre- and post-preparation specimens.

bur and water under the GSM at $\times 12$ magnification to simulate clinical conditions and no cracks were observed. The root-end preparations were prepared to a depth of three millimetres with the Waterlase laser using laser settings recommended by the manufacturer. There were again no cracks observed during or immediately after the procedure.

The thickness of remaining dentine is not of such a concern with the laser preparation, as it would be with ultrasonic or rotary instruments, because there is no vibration or pressure exerted during root-end preparation that may produce cracks. Methylene blue plus transillumination with magnification was used to detect dentinal cracks as

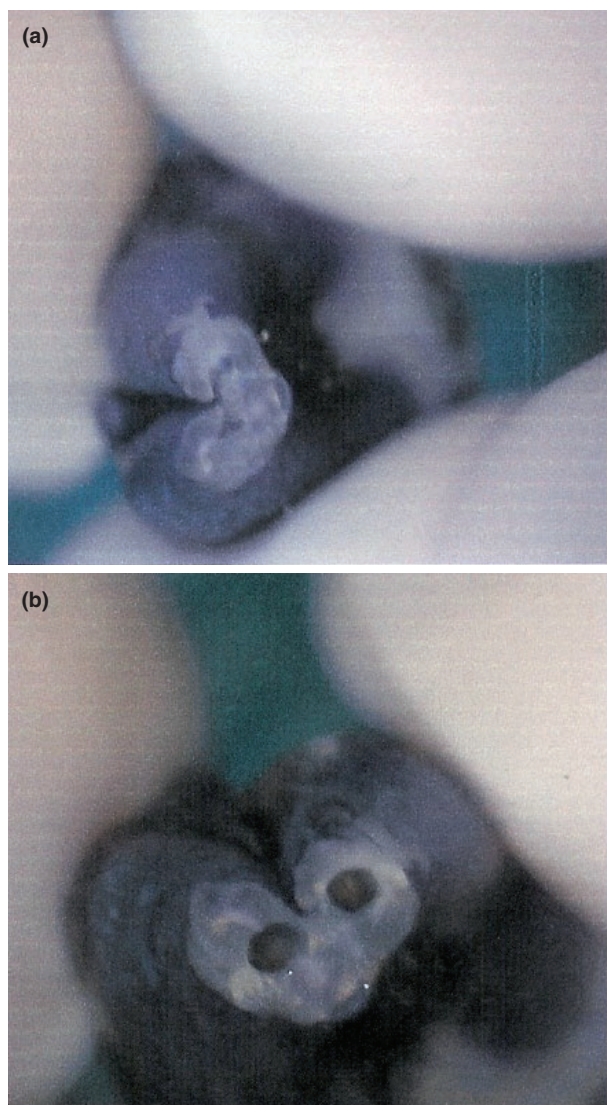


Figure 3 Pre- and post-preparation specimens.

recommended by Wright *et al.* (23). After 24 h in the methylene blue dye, the teeth were again evaluated and photographed with the GSM $\times 12$ magnification. They were again subjected to transillumination and FSM at $\times 40$ magnification and evaluated for under 2 min. Only one questionable intracanal crack was found. This may have initially been present but could not be detected until the root-end preparation was completed.

Connective tissue changes that occurs in response to other laser root surgery would not occur with the Waterlase as it is the energised water that does the cutting, not the laser. At present, no apical preparation laser micro-handpiece is available but such an instrument is under development. Teeth *in situ*, regardless of the method of

root-end preparation, do not exhibit a lesser tendency towards cracking than extracted teeth (12).

Based on this laboratory study, the Waterlase laser does not produce a clinically relevant rate of cracking when used to make endodontic root-end preparations. The next step is to use this laser in root-end preparations under clinical conditions with the GSM and to record the results with digital photographs.

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